



Temporal data visualizations for Air Traffic Controllers (ATC)

Christophe Hurter, Stéphane Conversy, Jean-Luc Vinot

► To cite this version:

Christophe Hurter, Stéphane Conversy, Jean-Luc Vinot. Temporal data visualizations for Air Traffic Controllers (ATC). CHI 2009, ACM Conference on Human Factors in Computing Systems, Apr 2009, Boston, United States. hal-00879033

HAL Id: hal-00879033

<https://hal-enac.archives-ouvertes.fr/hal-00879033>

Submitted on 31 Oct 2013

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Temporal data visualizations for Air Traffic Controllers (ATC)

Christophe HURTER

DGAC DSNR DTI R&D
7, Avenue Edouard Belin
31055, Toulouse France
christophe.hurter@aviation-civile.gouv.fr

Stéphane CONVERSY

ENAC
7, Avenue Edouard Belin
31055, Toulouse France
stephane.conversy@enac.fr

Jean-Luc VINOT

DGAC DSNR DTI R&D
7, Avenue Edouard Belin
31055, Toulouse France
Vinot@cena.fr

Introduction

Fundamental research in visualization is concerned with the impact of presentation on visual perception and understanding [5] [6].

In current Air Traffic Control (ATC) environments, Air Traffic Controllers (ATCo) use several visualization systems: radar views, timelines, electronic strips, meteorological views, supervisions etc. The information displayed is intrinsically temporal: aircraft positions that evolve over time, conflicts between aircraft at a given time, airspace congestions. Each of these visualizations is rich and dynamic: it displays numerous visual entities that move and evolve over time. Furthermore, this considerable volume of information must be understandable with a minimum cognitive workload. As traffic increases and safety criteria become more demanding ATC requires this new kind of visualizations.

Our research focuses on the production of new *efficient* visualizations with temporal data. We characterize a more *efficient* visualization as one in which a greater volume of information can be perceived and understood with a smaller or equivalent cognitive workload (while at the same time reducing the error rate in the perception of the information)



Figure 2: Halley's chart of the Trade Winds 1686.

ATC visualization derives some benefit of this comet. The design of the first radar comet is historical and technical. It is not directly based on the Halley design but on early radar equipment which relied on scope persistency (Figure 3). Old radar scopes retained the previous plot positions with the fading of the screen phosphor (ecological and technical design: the plot has a lifetime, the dot size and luminosity decrease over time). This kind of design has the same remarkable properties as the Halley-style comet: it displays the aircraft trajectory, curvature tendencies and shows if an aircraft is turning and the degree of veering. ODS is the main French radar view for the air traffic controllers. Its main goal is to display aircraft positions and to help ATCo to space aircrafts beyond the security minima. The radar track presents the aircraft positions, its speed (speed vector), name, altitude and speed as text (label). The design of the comet is built with squares, whose size varies with the proximity in time of the aircraft's position: the biggest square displays the

latest position of the aircraft, whereas the smallest square displays the least recent aircraft position. Thus, in Figure 4, the shape of the comet indicates that the plane has turned 90° to the right and that it has accelerated.

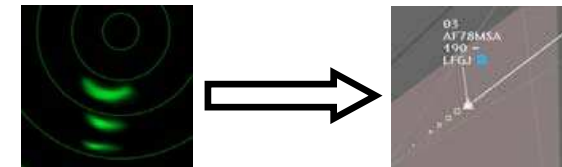


Figure 3: the shape decreases in intensity over time on a scope (left picture). ODS comet metaphor (right picture).

The positions of the aircraft merge through the effect of Gestalt continuity, in which a line emerges with its particular characteristics (curve, regularity of the texture formed by the points, etc). Furthermore, Gestalt continuity allows an occlusion resistance. This means that if there are many overlapping comets you can still distinguish each one.

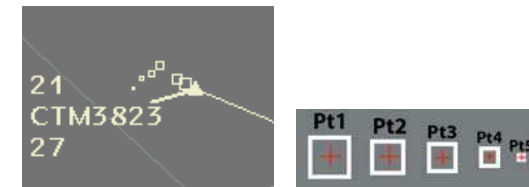


Figure 4: the French radar screen

The information coded by the comet is summarized in the following table. Italic script represents emerging information. For instance, the aircraft tendency data is

not needed to draw the comet, but the comet nevertheless codes this information. The emerging process stems from the embedded time in the RADAR plot positions. The time can be easily derived into speed and acceleration.

The comet design is an efficient visualization of data time. The fact that the underlying data is temporal helps the reader to interpret naturally emergent information such as speed, tendency and acceleration.

ODS coded information	Visual code
Aircraft position	Position
ageing of each position	Size
<i>Aircraft speed</i>	Size (comet length)
<i>Aircraft tendency (left, right)</i>	Comet curvature
<i>Aircraft acceleration</i>	Regular/irregular point spacing
<i>Aircraft entity</i>	Gestalt (proximity and size)

Conclusion:

In this paper we depict only one simple visual design used by air traffic controllers but it remains noteworthy through its numerous roots and the impressively large amount of coded information. This design illustrates the emerging information process. ATC use several other interesting temporal designs.

The comet design addresses some issues: the design is efficient because it displays more information than the simple aircraft positions (emerging information). Furthermore, this design is easily understandable because is ecological (metaphor of the phosphor persistency, and the comet design).

We should be very interested in participating in any workshop focussing on temporal data, especially if it addresses representation issues. The perspective of a special journal issue is also a promising project. The representation of temporal data is a part of the work of one of our Ph.D students. Therefore, we should be eager to take part and to benefit from the opportunity to contribute our expertise and our visualization experience.

References

- [1] J. Bertin , Graphics and Graphic Information Processing deGruyter Press, Berlin, 1977.
- [2] C. Hurter, S. Conversy: Towards Characterizing Visualizations. DSV-IS 2008:
- [3] C. Hurter, S. Conversy, V. Kapp, An Infovis approach to compare ATC comets ICRAT 2008
- [4] J. Norman, W. Thrower, Edmond Halley as a Thematic Geo-Cartographer, Annals of the Association of American Geographers, Vol. 59, 1969.
- [5] E.R. Tufte, The Visual Display of Quantitative Information, Graphics Press, Chesire, Connecticut, 1983.
- [6] C. Ware, Information Visualization, perception for design, Morgan Kaufmann, 2002.